

REMARKS

Introduction

Claims 1, 4, 7 and 12 have been amended to more particularly recite the subject matter of the claimed invention.

Claims 1-18 are presented for further prosecution on the merits in view of the preceding amendments and following remarks.

Office Action of May 22, 2002

In the outstanding Office Action mailed May 22, 2002, the Examiner:

1. objected to the drawings because the sectional views were not properly crosshatched, and required either a proposed drawing correction or corrected drawings;
2. rejected claims 1-7, 10-12, 16, and 17 under 35 U.S.C. § 102(b) as being unpatentable over United States Patent No. 5,767,580 to Rostoker ("the Rostoker reference"); and
3. rejected claims 8, 9, 13-15 and 18 under 35 U.S.C. § 103(a) as being unpatentable over the Rostoker reference.

Applicants respectfully traverse the objection to the drawings and traverse each of the two art-based rejections.

Objection to the Drawings

The Examiner objected to the drawings because "the sectional views were not properly crosshatched," and required either a proposed drawing correction or corrected drawings. Applicants submit herewith corrected drawings for Figs. 1-6. During a telephone conversation with the Examiner on October 8, 2002, the Examiner indicated that the objection to the drawings were directed to the unmarked and un-crosshatched rectangular elements in-between and adjacent the conductor pads. These unmarked and un-crosshatched rectangular elements in-between and adjacent the conductor pads have been deleted in the corrected drawings for Figs. 1-6 submitted herewith. Moreover, the Examiner inquired as to the identity of elements 14 and 18 in the drawings. During the telephone conversation with the Examiner on October 8, 2002, it was explained that elements 14 and 18 referred to planar elements and were not limited to "dielectric materials" as the Examiner initially suggested. In view of the corrected drawings submitted herewith and the comments relative thereto, applicants respectfully request that the objection to the drawings be withdrawn.

Rejection of Claims 1-7, 10-12, 16 and 17 Under 35 U.S.C. § 102(b)

In the outstanding Office Action, claims 1-7, 10-12, 16 and 17 of the subject application were rejected under 35 U.S.C. § 102(b) as being unpatentable over the Rostoker reference.

Regarding claims 1, 2 and 3, the Office Action states:

Rostoker discloses, an array (only one shown) of resilient solder bonding structures, each one comprising a solder ball (700c) having a curved exterior surface enclosing a first volume and having an interior cavity (730) having a displacement constituting a second volume, the solder ball connecting at least one metal contact on a first surface (710c) to at least one metal contact on a second surface (750) [claim 1], wherein the second volume is not less than about 1 % of the first volume [claim 2], wherein the second volume is not more than about 90% of the first volume [claim 3].

Office Action of May 23, 2002, at p. 3.

Applicants respectfully disagree that the Rostoker reference discloses and teaches each and every element of the present invention as claimed in claims 1, 2 and 3. Applicants respectfully submit that the teachings of the Rostoker reference have been misinterpreted and misapplied.

According to Rostoker, element 700c is disclosed as follows:

Throughout the description, contacts on the first substrate are generally referred to as "balls", whether in the general shape of a sphere or in the shape of a pin, and contacts on the second substrate are referred to as "bumps". Generally, the contacts on the first substrate are generally convex, and the contacts on the second substrate are generally concave. In this manner, the balls align (nest) into the bumps. It is assumed throughout the description that the balls and bumps are formed on conductive bond pads disposed on surfaces of the respective first and second substrates.

The Rostoker reference, col. 6, lines 27-36.

Accordingly, the Rostoker reference characterizes the "conductive bump" as being on the second substrate and generally concave. The Rostoker reference further states:

Fig. 7c is a perspective view of a "formed" conductive bump contact 700c, formed by building up a conductive contact structure 720 on top of a round, vented bond pad 710c, similar to that shown and described with respect to Fig. 7a. The conductive contact structure has, in the vertical direction, as depicted, substantially the same vented ring shape as the bond pad 710c. Hence, the contact structure is cylindrical in shape, with a slit through its wall. A centrally located "well" 730, (corresponding to the opening, e.g. 715a, in the bond pad 710c) is formed. A gap 745 in the ring shape of the conductive contact structure 720 extends the vent 740c of the bond pad vertically through the conductive contact structure, creating a "gapped", cylindrical shape.

The Rostoker reference, col. 11, line 59 to col. 12, line 4.

In contrast to the Office Action's characterization of element 700c as a "solder ball," it is clear that the Rostoker reference characterizes element 700c as a "conductive bump contact [that is] formed by building up a conductive contact structure 720 on top of a round, vented bond pad 710c ... [t]he conductive contact structure [having], in the vertical direction ... substantially the same vented ring shape as the bond pad 170c." In summary, "the contact structure is cylindrical in shape, with a slit through its wall ... [and a] gap 745 in the ring shape of the conductive contact structure 710 extends the vent 740c of the bond pad vertically through the conductive contact structure, created a 'gapped', cylindrical shape."

Accordingly, applicants respectfully submit that the "generally concave" bumps of the Rostoker reference are not "solder balls" as asserted in the Office Action, but instead are contact structures. Moreover, as noted above, the "conductive bump" of the Rostoker reference is a contact structure that is cylindrical in shape, with a slit or vent through its wall and does not have a continuous curved exterior surface completely enclosing a first volume and a having a completely enclosed interior cavity having a

displacement constituting a second volume. The vertical slit or vent in the cylindrical contact structure allows for out-gassing of gases from the flux during heating which is quite the opposite of what occurs in the present invention as claimed where the gases from the flux are completely enclosed within the interior cavity to provide the expanded shape to the finished barrel-shaped conductive solder structure. In fact, given the teachings and disclosure in the Rostoker reference relative to the vertical slit or vent for out-gassing gases from the flux, applicants respectfully submit that the Rostoker reference actually teaches one of skill in the art away from the present invention as claimed wherein the gases from the flux are completely contained and used to expand the solder ball to the desired expanded shape of the finished barrel-shaped conductive solder structure.

Comparing the structure of the Rostoker reference with the embodiments of the present invention, paragraphs 25-26 of the present application provide:

As the vapor expands during solder heating and liquefaction, a first interior cavity is formed at each array location on upper planar element 14 that is contained by the surface tension and viscosity of the molten solder. The first interior cavity joins with a second interior cavity similarly formed on lower planar element 18 to produce the resulting interior cavity 28.

The surface tension properties also force the formation of an exterior convex shape on the liquefied structure, that when cooled, solidifies in the barrel-shaped form of Fig. 3, due to solidification of the outer shell before the vaporized fluxing agent in the interior can contract.

The above recitation describes an inflating effect of the heated interior gaseous flux entrapped by the surface tension of the molten solder to create a convex (barrel-shaped) structure. The resulting structure is continuous and completely encloses the inner volume. On the other hand, the "slit" or "vent" advanced in the Rostoker reference for out-gassing of the gaseous solder flux would prevent the formation of the inflated barrel-

shaped structure, since it is not completely enclosed, and thus has no expansion capabilities.

The resulting barrel-shaped conductor of the present invention exhibits superior resiliency when subjected to lateral forces resulting from disparate movement of the joined planar surfaces, which is the thrust of the instant invention. Applicants respectfully note that it is the expansion effect that allows for the creation of uniformly thin walls of the present invention, which in turn provide the resulting resiliency to stress forces. The Rostoker reference contains no teaching and no suggestion to such resiliency of the resulting structure, only to the mating alignment of the solder ball into the "detented" concave structure.

It is for the above-mentioned reasons that applicants respectfully submit that the Rostoker reference does not anticipate the present invention as set forth in the claims thereof, and that, in view of these significant differences between the solder ball of the present invention and the contact structure of the Rostoker reference, claim 1 is believed to be patentably distinct from the prior art cited. Accordingly, reconsideration and withdrawal of the rejection of claim 1 is respectfully requested.

In regard to claims 2 and 3, applicants respectfully submit that the Rostoker reference contains no teaching or suggestion as to a second volume (i.e., the enclosed cavity) of between 1% and 90% of a first volume (i.e., the enclosing barrel-shaped structure). In fact, there is nothing in the Rostoker reference to support the assertion in the Office Action that the Rostoker reference discloses and teaches, much less suggests, a second volume as being between 1% and 90% of the first volume. In fact, there is no

disclosure, teaching, or suggestion in the Rostoker reference as to any form of volumetric displacements, either relative or absolute. Accordingly, it is respectfully submitted that claims 2 and 3 are allowable over and not anticipated by the Rostoker reference.

Regarding claims 4-7, 10-12, 16 and 17, applicants submit that for the same reasons as discussed and advanced above relative to claims 1-3, claims 4-7, 10-12, 16 and 17 are also allowable over and not anticipated by the Rostoker reference.

Rejection of Claims 8, 9, 13-15 and 18 Under 35 U.S.C. § 103(a)

Claims 8, 9, 13-15 and 18 were rejected under 35 U.S.C. § 103(a) as being unpatentable over the Rostoker reference.

In view of the fact that claims 8, 9, 13-15 and 18 are dependent claims based on independent claims now believed allowable, it is also believed that claims 8, 9, 13-15 and 18 are allowable as depending from an allowable base claim. Accordingly, reconsideration and withdrawal of the rejection of claims 8, 9, 13-15 and 18 are also respectfully requested.

In summary, the teachings of the Rostoker reference would not lead one having ordinary skill in the art to the present invention, but rather would lead away from the present invention. The present invention was specifically promulgated to overcome deficiencies relating to lateral stress on ball grid array connections, not simply to have a concave/convex ball grid vertical mating alignment for ease of manufacturing.

Conclusion

In view of the amendments and remarks made herein, applicants respectfully submit that claims 1-18 of the present application as claimed are now in condition for allowance, and notification to that effect is respectfully requested.

Finally, while applicants believe that the instant response places the application in condition for allowance, if the Examiner believes that additional discussion or further information is necessary, it is requested that the Examiner contact the undersigned at the telephone number listed below to expedite resolution of any outstanding issues.

In view of the foregoing amendments and remarks, favorable reconsideration is respectfully requested, and an early Notice of Allowance is earnestly solicited.

Respectfully submitted,

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Date: October 21, 2002



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If fee payment is enclosed, this amount is believed to be correct. However, the Director is hereby authorized to charge any deficiency or credit any overpayment to Deposit Account No. 50-1645.

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